Space Weather Technical Forecast

Issued on Tuesday, 26 September 2023 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Isolated M-flares likely, with a slight chance of X-flares (R1-R3 Radio blackouts). Slight chance of G1-G2 minor/moderate geomagnetic storms Day 1 (26 Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low activity, with a long period C9.8 flare observed at 25/0813UTC, originating from AR3445. There are currently ten sunspot regions on the visible disc. AR3445 has been the most active and developmental region on the disc, with a persistent small delta spot on its southern portion, although this appears to be weakening at present. AR3443 in the northwest and AR3435 in the west-centre disc have persisted as moderately sized regions, with AR3443 seeing continued activity from a small reverse polarity trailing spot. AR3435 remains notable with a small delta spot on its northern portion, but activity has been quiet. AR3447, lies to the southeast of AR3445, and continues to develop. It is currently in a beta magnetic configuration, and has already seen some activity, so this region will continue to be monitored. The newly numbered AR3448 continues to rotate around the northeastern limb.

A number of eruptions were observed over the western limb, but are considered to be far-sided with no significant Earth component. The aforementioned long period C9.8 flare peaking at 25/0813 from AR3445 saw some dimming on imagery and may result in a possible CME, this will be looked at once relevant coronagraph imagery is available.

No other Earth-directed CMEs have been observed in the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar winds have been at mostly slightly elevated levels throughout much of the period, due to the effects of a CME which arrived at Earth on the UTC evening of the 24 September. Speeds have ranged between 420-500km/s. Density has been average to above average, with a peak of 37 ppcc at 25/1150UTC. The Interplanetary magnetic field strength (IMF), Bt, has been strong or very strong throughout, with a peak of 34nT at 25/1007UTC, with a gradual declining trend. The north-south component (Bz) was negatively strong, peaking -17nt at 25/0323UTC, before increasing to become positively strong or very strong, with a peak of 33nT at 25/0756UTC, with a gradual declining trend towards moderate levels at present. Phi angle started at mostly negative (towards the Sun), then became predominately positive (away from the Sun) from 25/0730UTC. Resultant geomagnetic activity was G1/Minor Storm (Kp 5) between 25/0000-0600UTC, with activity reducing to Active/Unsettled (Kp 3-4) from 25/0600UTC, and is currently at Quiet levels (Kp 1-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at background levels. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold and on a declining trend. The observation at 25/0001 UTC was 1.11e6 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast with further isolated M-flares likely, and a slight chance of rising to High due to the potential for isolated X-flares from AR3445 in the south.

Solar Wind / Geomagnetic Activity: Further CME arrivals are possible into Day 1 (26 Sep). Confidence is low however, with glancing impacts most likely. Solar winds are likely to remain at slightly elevated levels early on day 1 (26 Sep) reducing to slow-ambient levels, with the absence of any further CME arrivals. Geomagnetic activity will be mostly Quiet to Unsettled (Kp2-3, with a slight chance of Active (Kp 4) to G1-G2/Minor-Moderate (Kp 5-6) on Day 1 (26 Sep) should any subsequent glancing CMEs occur. Quiet to Unsettled (Kp1-3) activity is then expected to dominate from Day 2 (27 Sep).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur.

High energy electron flux (greater than 2MeV) has become background due to a CME arrival on 24 Sep. Further CME glancing blows may continue this trend, though confidence reduces later in the period with a chance or returning to high by Days 3 and 4 (28-29 Sep). The associated 24 hour fluence is in a declining phase and will likely remain below the Active threshold until at least Days 3 and 4 (28-29 Sep), though any increase is low confidence.

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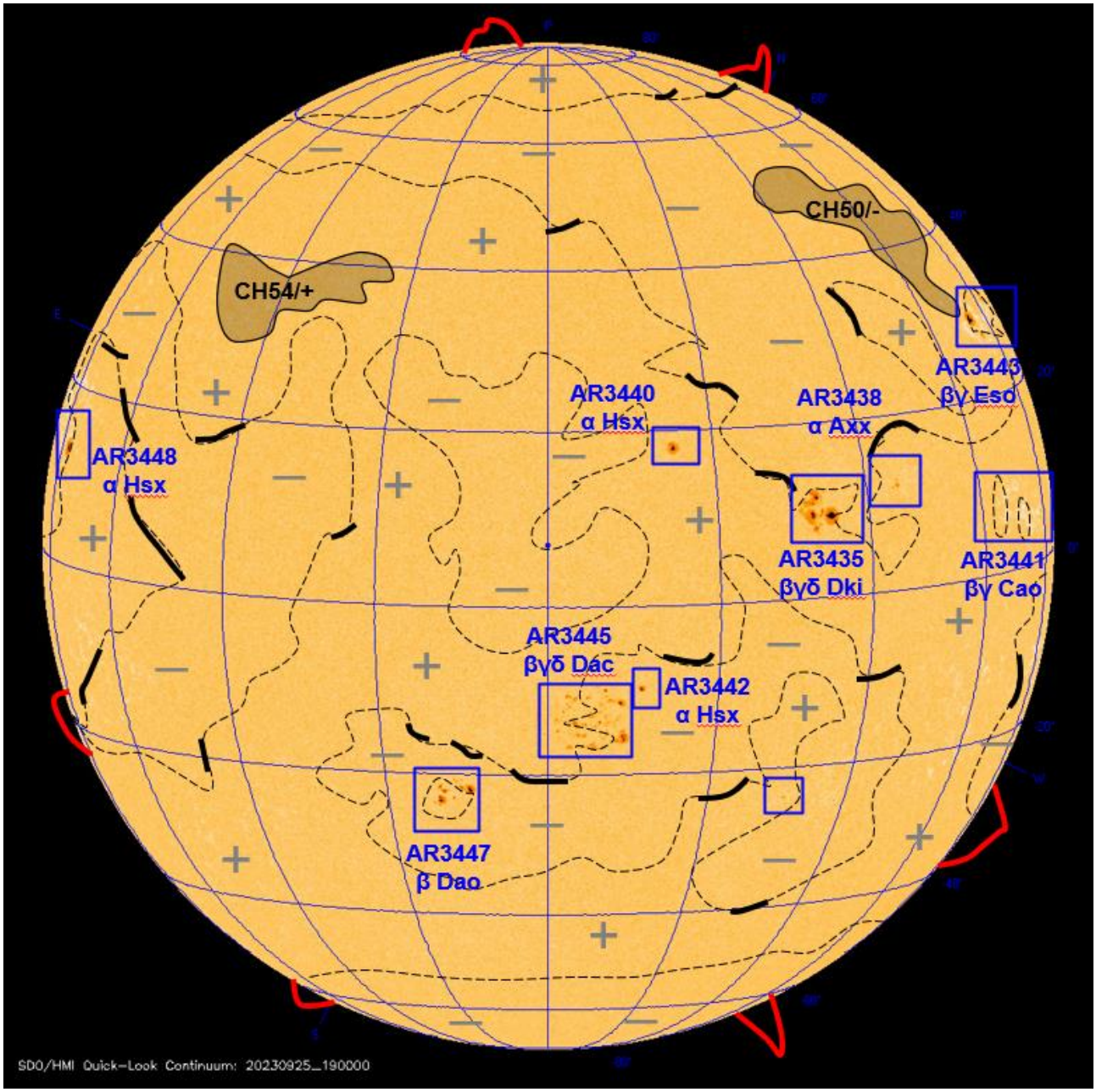
Figure 1. Solar Analysis Valid 25/1900UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast is currently low confidence due to the number of CME's that have recently left the Sun. The CME associated with the long period M1.2 flare from 22/0336 UTC arrived late on the 24 Sep. This may have swept up and combined with other CMEs from 20 Sep and 21 Sep. The effects of the CME are beginning to wane.

There remains the potential for arrivals from two further CMEs from early on 22 Sep. The first from south of the AR3435/38 complex spot, and a further one to the north of this region. These are both weak eruptions but give a slight chance of further enhancements on Day 1 (26 Sep) but these are very low confidence. Other CMEs which feature in the forecast are from the double peak M1.5/1.4 flare at 22/1621 UTC and 22/1714 UTC of AR3443 in the northwest and from the M1.9 flare at 22/2300 UTC from AR3435/38. These CMEs are currently expected to be missing Earth but may give slight glancing impacts, potentially combined within the material in the aforementioned CMEs.

Further CMEs were observed leaving the Sun from the western limb on 24 Sep. Most appear to be far-sided, with a suggestion one could give a weak glancing blow late on Day 3 (Sep 28), although this is low confidence.

Overall this gives a very low confidence geomagnetic forecast. Geomagnetic activity will be mostly Quiet to Unsettled (Kp2-3) at first, with a slight chance of Active (Kp 4) to G1/Minor Storm (Kp 5) on Day 1 (26 Sep) should any subsequent glancing CMEs occur. Quiet to Unsettled (Kp1-3) activity is then expected to dominate from Day 2 (27 Sep). However, a further enhancement is possible late on Day 3 (28 Sep) with another glancing CME, but this is very low confidence at this point.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	20	10	20
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1134	Partial	Filament	NW	592 km/s	26 Sep	Missing/glancing
22/1504	Partial	Filament	SW	497 km/s	26 Sep	Missing/glancing

Figure 2: ENLIL (top) and Ensemble (bottom) showing sequence of possible CME arrivals – low confidence.

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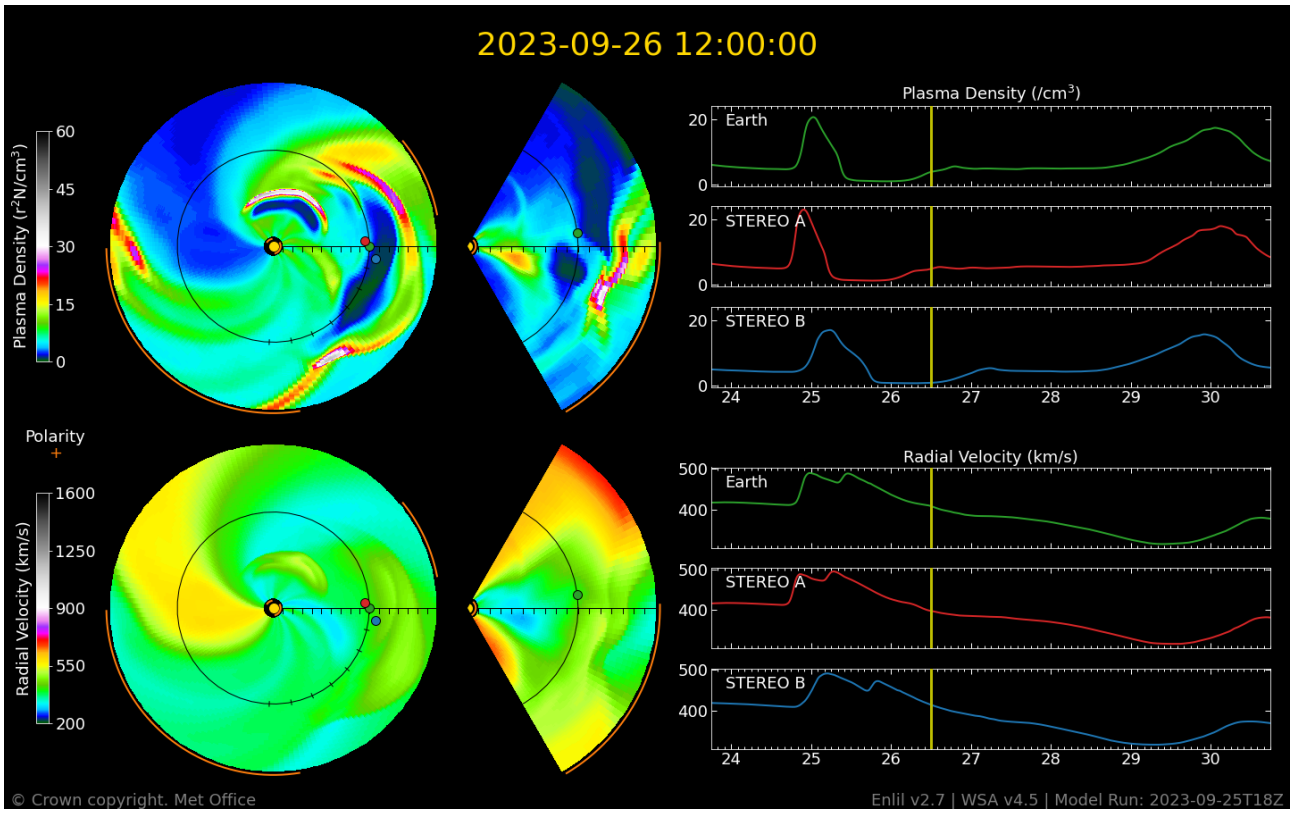

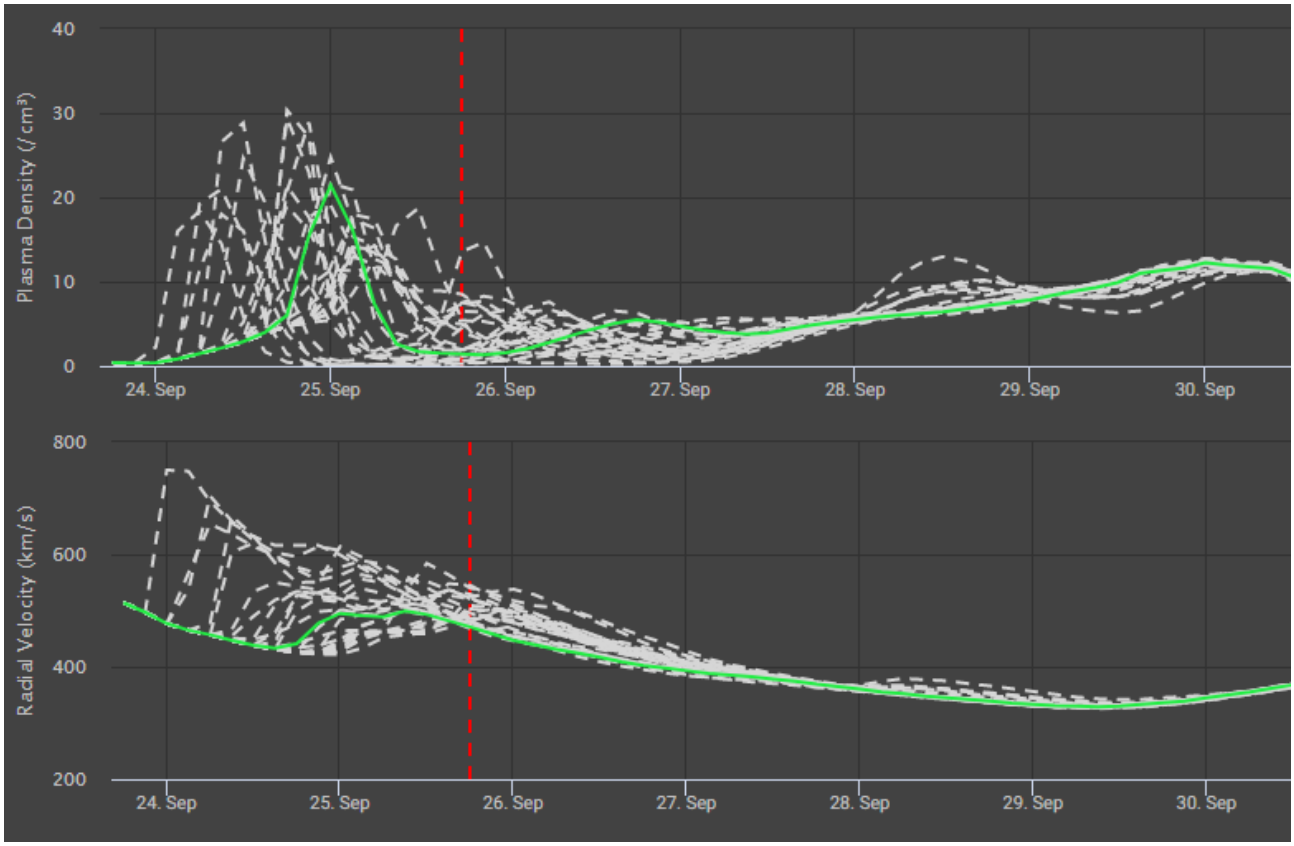

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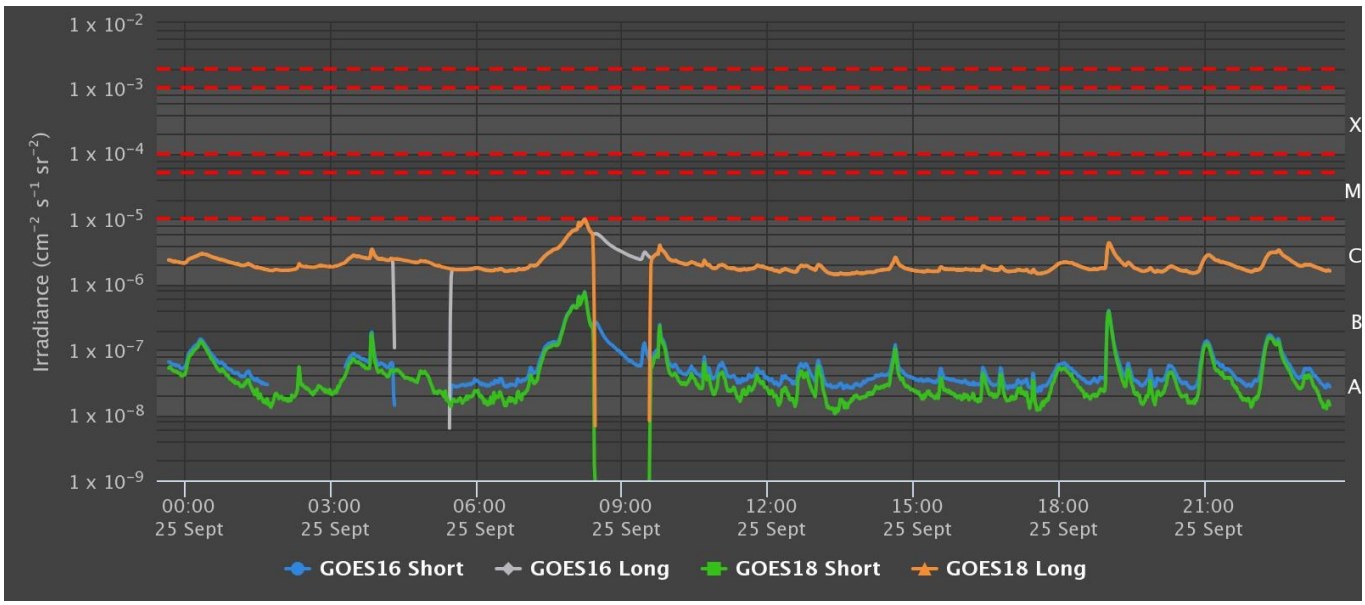
Radio Blackouts - X-Ray Flares:
Moderate activity is expected with an ongoing likelihood of further M-flares through the period, and a slight chance of rising to High with the potential for isolated X-flares. This is due to the current number of spots (ten) and the complexity of at least two.

AR3445 in the southeast quadrant has a small mixed polarity region, with a delta spot in its southern portion, although is showing signs of weakening. AR3435 and AR3443 both remain larger regions. AR3435 in the west perhaps remains the more notable of these two, at least magnetically, with a delta spot in its northern portion, but has been fairly quiet. AR3443 has been the more active, with a reverse polarity spot that formed close to its trailing spots being the source for a number of flares. AR3447 has formed to the southeast of AR3445, growing quickly with some recent flare activity, this will continue to be monitored for any further development.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	20	15	10	10

Figure 3: GOES16-18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is likely to persist at background to moderate levels, however there are regions either on, or moving onto the western disc which bring a chance of flux levels rising above background given the occurrence of any significant flares. This includes AR3443 and AR3435, as well as AR3445 in the south.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	15	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

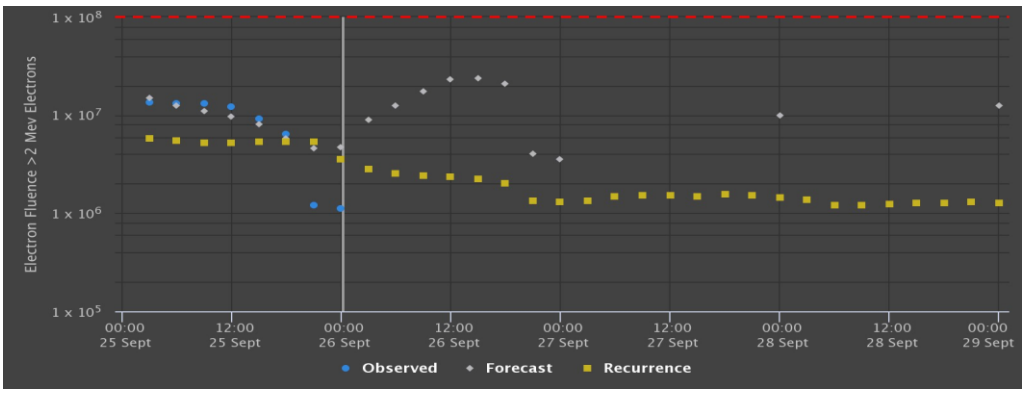
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 has reduced to background levels following the arrival of the CME on the UTC evening of the 24 Sep. Further CME glancing blows may continue this trend, though confidence reduces later in the period with a chance or returning to high by Days 3 and 4 (28-29 Sep).

The associated 24 hour fluence is in a declining phase and will likely remain below the Active threshold until at least Day 4 (29 Sep), though any increase is low confidence. REFM is currently giving good guidance of the expected trend, remaining below Active throughout.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM electron fluence



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